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UGANDA SIMULIIDAE

By E. G. Gibbins.

[Read 20th November, 1935.]

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Introduction.

In presenting a further contribution to the study of African Simuliidae it is opportune to draw attention to the growing importance of these small flies in the rôle of the transmission of human disease. Recent researches into the cause of blindness amongst natives in certain regions of the Belgian Congo (Hissette, 1932), Central America (Strong, Sandground, Bequaert, and Ochoa, 1934) and the Sudan (Bryant, 1935) have shown the condition to be due to microfilariae of the genus *Onchocerca* which are carried by Simuliid flies. Such ocular complications of onchocerciasis are reported to be of recent origin in the Belgian Congo and the Sudan, and it may be conjectured that civilisation has in some way contributed towards its appearance by providing more suitable watercourses for the propagation of the dangerous species of *Simulium*.

Nine closely related species of *Simulium*, five of which are new to science, form the subject of the present study. A note is also included giving further observations on the range of flight of *S. damnosum* Theo. The male and female, the early stages and the breeding-places of each species is described with the exception of the larva of *S. rotundum* sp. n., which is unknown. Mr. Pomeroy's species are redescribed from Uganda specimens. Details of the male terminalia and the respiratory organ of *S. adersi* Pom., which was dealt with in a previous paper (1934), are figured in order that the study may be as complete as possible. The adults are described from specimens bred from isolated pupae and the larvae have been correlated by dissecting out the nymphal respiratory organ. With the exception of the male terminalia, which was dealt with in a recent paper (1935), the terminology used throughout is that of previous studies. The drawings were made by myself after the parts had been dissected out and carefully mounted without compression.

The breeding-place of *S. tentaculum* sp. n. is of particular interest. Pupae

of this species were found on small black stones which were peppered with minute round holes. The mature larva chooses one of these small holes, pupates and constructs a cocoon which completely covers it, leaving little more than its many slender respiratory filaments exposed to the vagaries of the current of the swiftly flowing stream.

Range of Flight of *Simulium damnosum* Theo.

In a previous communication (1933) reference was made to the range of flight of *S. damnosum*. Further observations extending over a period of four years tend to show an even wider dispersal of the species than was then predicted. During this time Kampala, a town situated about 45 miles as the crow flies from the only known breeding-place of *damnosum* in the River Nile, was twice invaded by the female fly. Both occasions were in January, 1934 and 1935, during the dry season and coincided with greatly increased density of the fly in the region of the Nile; the adults were extremely abundant in the intervening countryside, and on the last occasion the insect tormented the inhabitants of Kampala for several days with its cruel bite. All the important streams and rivers in the surrounding country have been repeatedly searched, and though the early stages of many different species have been found not a single example of *damnosum* was taken. In the above-mentioned paper when describing the breeding-places of *S. damnosum*, it was shown that the degree of aeration of the water was the all-important factor. With the one possible exception of a small area at the base of the Sezibwa falls, none of the watercourses investigated appeared to be of sufficient aeration for *damnosum*. This one particular area of the river, although not exhibiting the same high degree of aeration as found beneath rapids in the River Nile, is the only other place in this part of the country where the aeration of the water in anyway approaches that which appears to be necessary for the development of the early stages. However, all attempts to find the larva and pupa failed, but even supposing *damnosum* does breed here the aerated area is so small (a few square yards in extent) that it would be difficult to imagine that it could be responsible for such an abundance of flies and the invasion of the township of Kampala some 25 miles distant. Furthermore, it is unlikely that the early stages were missed, as if their development were possible in the smaller rivers of Uganda the country would be overrun by the species, whereas it is only at periods of great density that the fly is found so far from its breeding-place.

Specific Descriptions.

The adults of the species here dealt with are characterised by the absence of soft hairs from the membrane behind the thoracic spiracle (except in the case of *S. adersi*, which has a patch of silver-grey scales), eleven-segmented antennae covered with a fine ash-grey pubescence, front of normal width in the ♀ and eyes closely approximated in the ♂, hind legs with calcipala present and pedisulcus distinct, front tarsi not flattened, spermatheca oval, strongly chitinised and smooth, claws with a well-developed basal projection and terminalia of similar structure in the ♀, ♂ terminalia with the posterior part of the phallosome of similar type, wings with spines interspersed with hairs on the costa, hairs on the base of the radius, the radial sector simple and the cubitus with a distinct double bend. The larvae have palps and anal armature of the usual type, and antennae consisting of four segments, the second segment twice as long as the first and bearing at its distal end two knob-shaped sensory

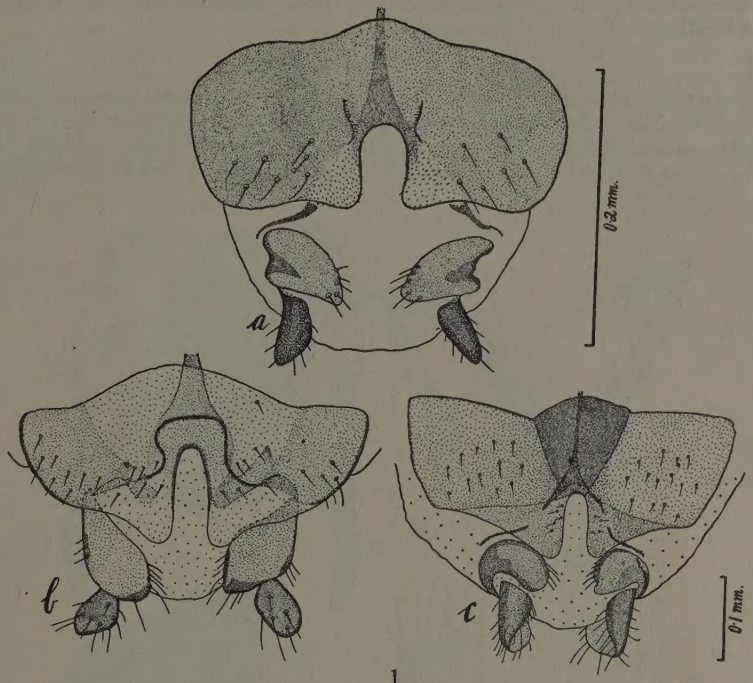

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FIG. 1.—Female terminalia, ventral view: *S. tentaculum* (*a*), *S. hirsutum* (*b*), *S. brachium* (*c*). (*b* and *c* to same magnification.)

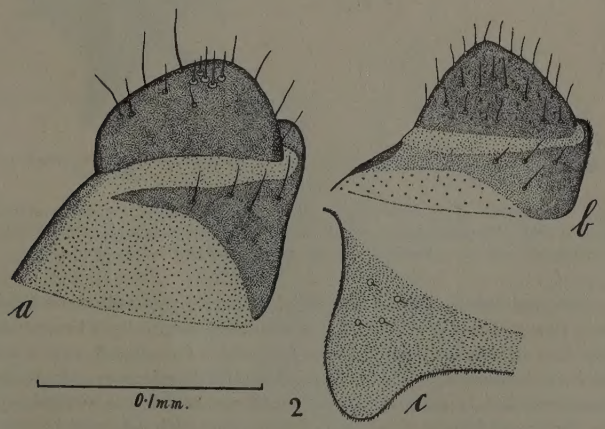

FIG. 2.—Female terminalia, lateral view: *S. hirsutum* (*a*), *S. brachium* (*b*); ventral view of anterior gonopophyse of *S. brachium* (*c*).

processes, third about as long as the first and lightly chitinised, fourth consisting of a small cone.

Simulium hirsutum Pom.

♀. Length, 2 mm.; wing, 2·5 mm. *Head.* *Vertex, front* and *clypeus* slate-grey covered with golden hairs. *Antenna* dark brown with the exception of the scape and the first flagellar segment which are light brown. *Thorax.* *Mesonotum* dull black, densely and uniformly covered with closely applied golden scales. *Scutellum* dull black, with long

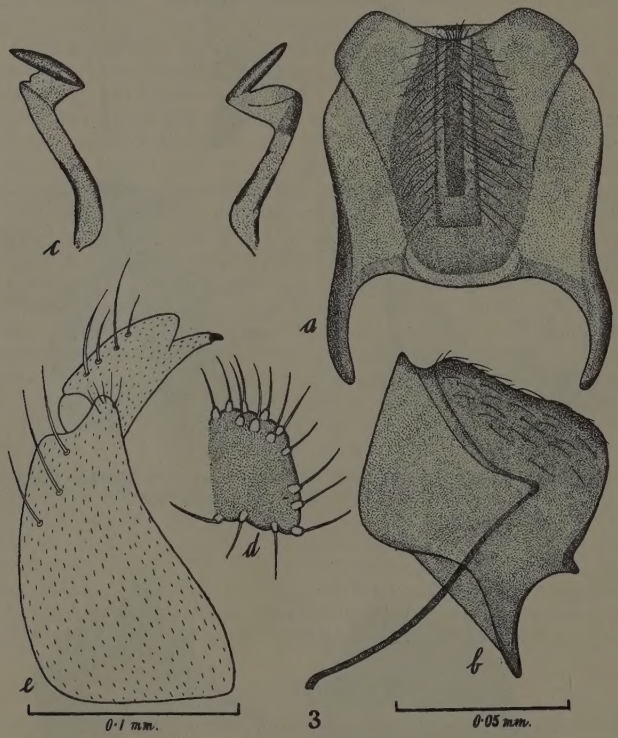

Fig. 3.—Male terminalia of *S. hirsutum.* Phallosome: anterior part, ventral view (*a*), lateral view (*b*); posterior part, dorsal view (*c*). Anal circus (*d*). Coxite and clasper, ventral view (*e*). (*a*, *b*, *c*, and *d* to same magnification.)

outstanding marginal hairs. *Pleura* slate-blue. *Halteres* pale yellow with brown stem. *Abdomen* dark brown, covered with golden scales; first tergite light brown with a fringe of moderately long pale yellow hairs. *Terminalia* (fig. 1 *b*). *Eighth sternite* with a broad median lightly chitinised area; *anterior gonopophyses* lightly spiculate and rounded distally; *paraprocts* large and lightly chitinised; *cerci* small and rounded in ventral aspect. *Legs* dark brown; femora and basal two-thirds of tibiae pale with golden pubescence. *Wings* pale, without basal cell; subcosta lacking hairs.

♂. Length, 1·5 mm.; wing, 2 mm. *Head.* *Clypeus* slate-grey sparsely covered with

golden scales. *Antenna* dark brown. *Thorax. Mesonotum* velvet-black, thickly covered (except in the median area) with closely applied brassy scales. *Scutellum* black with long outstanding golden hairs. *Pleura* as in ♀. *Halteres* bright yellow with brown stem. *Abdomen* velvet-black, thinly sprinkled with golden scales; first tergite of similar colour with lateral fringe of long pale yellow hairs; second segment densely covered with moderately long narrow golden scales situated between two large grey iridescent lateral patches; fifth and sixth segments with a conspicuous light grey iridescent lateral patch. *Terminalia* (fig. 3). *Coxite* about twice the length of the clasper, in ventral view it appears broad at the base and narrows gradually to about half its basal width apically; the inner ventral

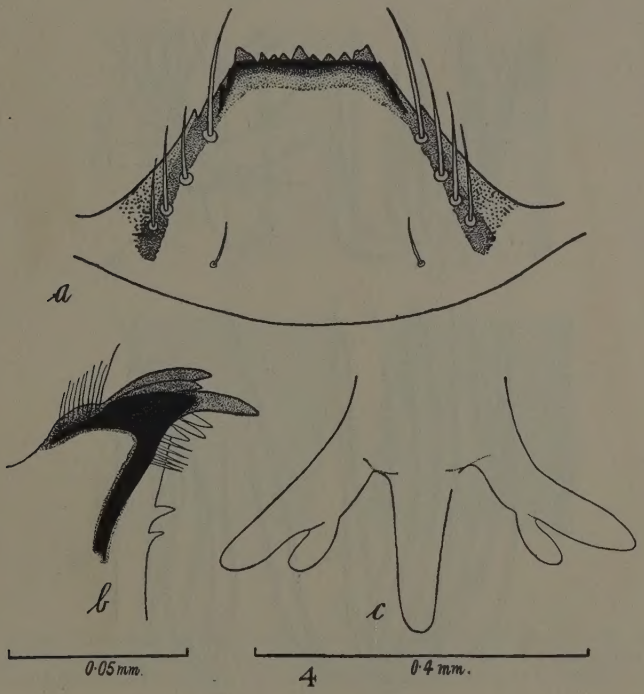

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Fig. 4.—Larva, *S. hirsutum :* mentum (*a*), mandible (*b*), anal gills (*c*). (Magnification of *a* as in fig. 2.)

side is continued into a short rounded process. *Clasper* broad, narrowing in the anterior third into an upper rounded process and a lower finger-like projection which terminates in a strongly chitinised tooth. *Phallosome : anterior part* (fig. 3 *a* and 3 *b*) broad and square with a large V-shaped median area; *posterior part* (fig. 3 *c*) with small chitinised conical parameres. *Cercus* (fig. 3 *d*) small, and surrounded on three sides with strong bristles which have pronounced bases. *Legs* dark brown, front femora with dull golden scales. *Wings* as in female except for the presence of a few dark hairs near the base of the subcosta.

Larva. Length, 5 mm. General colour light grey. *Head. Front* without pigmented areas. *Antenna* about half as long again as the base of the feeding-brushes. *Mandible* (fig. 4 *b*) with a long main and two shorter strongly chitinised teeth; from the concave surface of the former protrude three large and five small secondary teeth. *Mentum* (fig. 4 *a*)

with a terminal row of nine chitinised teeth, the median and the outer which has a shoulder on its inner edge are the longer; on either side lie a single oblique row of four stout spines with a pair of strongly chitinised teeth situated between the distal spine and the outer tooth; in the submedian area a little above the base is a small single spine. *Feeding-brushes* with 30–35 long bristles. *Thorax. Thoracic pseudopod* cylindrical and about as long above as the distance below the head suture. *Abdomen.* Terminal segments covered with short spines dorsally; last segment with a pair of ventral tubercles. *Anal gills* (fig. 4 *c*) trilobed, the median simple and the outer with a small thumb-like lateral projection. *Anal sucker* with about 104 rows each with 10–15 stout hooks.

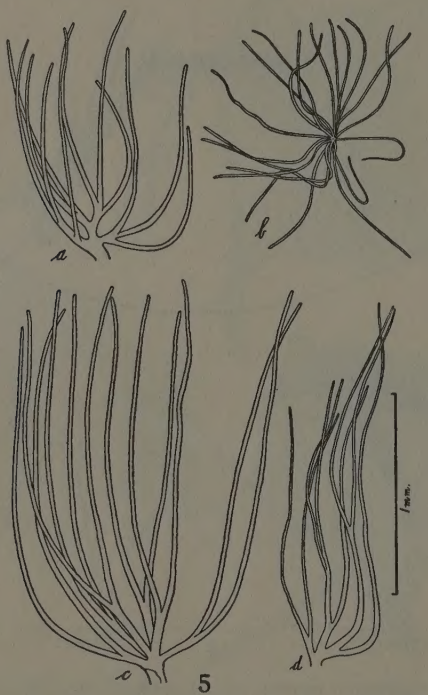

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Fig. 5.—Pupa, respiratory organ: *S. adersi* (*a*), *S. tentaculum* (*b*), *S. duodecimum* (*c*), *S. hirsutum* (*d*).

Pupa. Head and *thorax* without disc-like tubercles; trichomes simple, short and slender. *Respiratory organ* (fig. 5 *d*) pale and semi-translucent. Under high magnification the outer wall (fig. 6 *c*) is seen to be covered with very minute pigmented nodules which are arranged in rows over the entire surface with the exception of the base. The eight slender filaments arise from three main stems and divide a short distance from the base, giving rise to six slender filaments, two of which, one from each of the two pairs, divide again one slightly anterior to the other. *Abdomen.* Eighth segment encircled with a row of strong downward projecting spines. Terminal segment with two short inwardly curved hooks. *Dorso-lateral surface:* third and fourth segments with four equally spaced hooks. *Ventro-lateral surface:* fourth segment with a bifid spine, fifth with two closely spaced

bifid spines, sixth and seventh with two spines, one bifid and one simple, which are widely spaced.

The cocoon (figs. 7 *a* and *b*) is a dark brown gelatinous pocket about 3·5 mm. in length neatly interwoven with fine threads.

Breeding-places.

Larvae and pupae of *S. hirsutum* were associated with those of *S. cervicornutum* in the River Nabigwo at an altitude of 4,000 ft. They were found in the heavily shaded parts of the stream on loose stones, both smooth and

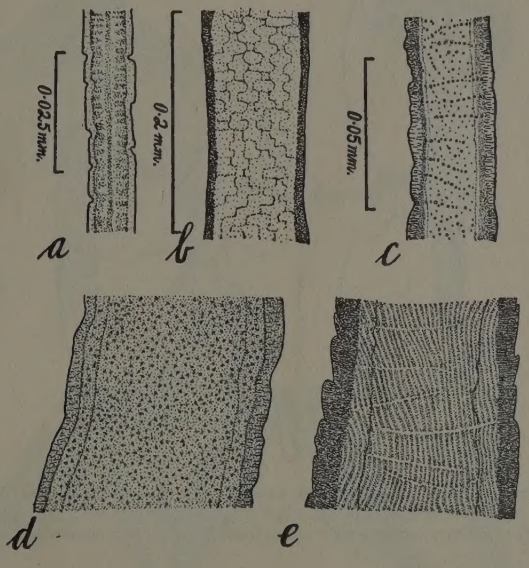

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FIG. 6.—Pupa, outer wall of respiratory organ highly magnified to show its structure. *S. tentaculum* (*a*), *S. ruficorne* (*b*), *S. hirsutum* (*S. adersi* and *S. duodecimum* similar) (*c*), *S. brachium* (*d*), *S. simplex* (*e*). (Magnification of *d* and *e* as in fig. *c*.)

rough, lying beneath cascades on the blades of elephant grass dipping in the swiftly flowing water.

Simulium duodecimum sp. n.

♀. Length, 2 mm.; wing, 2 mm. *Head. Vertex*, *front* and *clypeus* slate-grey thickly covered with narrow silver-grey scales. *Antenna* brown, with the exception of the scape, first and base of second flagellar segments which are yellow. *Thorax. Mesonotum* dull black with three indistinct narrow median black stripes, thickly covered with short narrow golden scales. *Scutellum* of similar colour, densely covered with golden scales and long marginal erect hairs. *Pleura* slate-grey. *Halteres* pale yellow with brown stem. *Abdomen* metallic brown, covered with golden scales; first tergite pale yellow with lateral fringe of hairs of similar colour; sixth, seventh and eighth segments with long dark apical hairs. *Terminalia* as in *S. hirsutum*. *Legs* bright yellow, covered with yellow scales with the

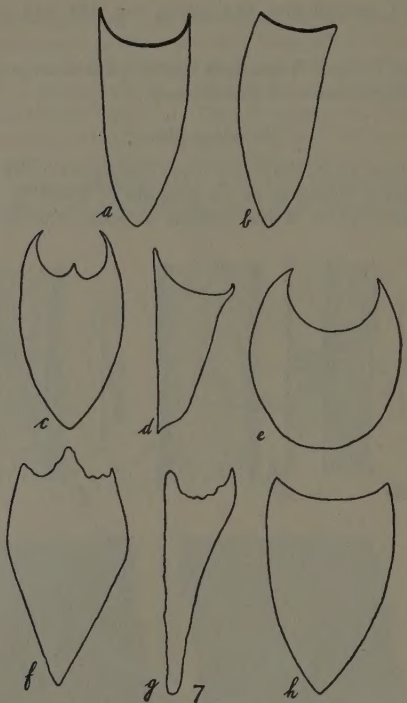

FIG. 7.—Cocoon. Outline drawings, not to scale. *S. hirsutum*, ventral view (*a*), lateral view (*b*); *S. unicornutum*, ventral view (*c*), lateral view (*d*); *S. tentaculum*, ventral view (*e*); *S. ruficorne*, ventral view (*f*), lateral view (*g*); *S. brachium*, ventral view (*h*).

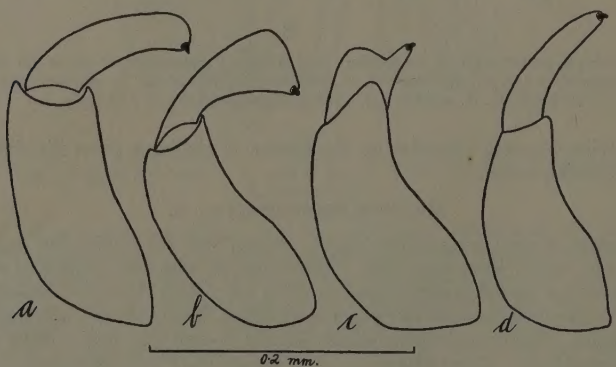

FIG. 8.—Male terminalia. Coxite and clasper, *S. brachium* (*a*), *S. ruficorne* (*b*), *S. adersi* (*c*), *S. duodecimum* (*d*).

exception of the fore and mid tarsi, the apical third of the femora, tibiae and first tarsal segment and the remaining segments of the hind tarsi which are dark brown. *Wing* as in *hirsutum* but with hairs along the basal two-thirds of the subcosta.

♂. Length, 2·5 mm.; wing, 2·1 mm. *Head. Front* and *clypeus* slate-grey with sparse long pale hairs. *Antenna* as in female. *Thorax* and *scutellum* dull black, densely and uniformly covered with deep golden scales, the latter with long golden marginal hairs. *Pleura* as in female. *Halteres* light brown, darkly edged apically and with a dark brown stem. *Abdomen* dark velvet-brown, sparsely sprinkled with narrow dull golden scales; first tergite light brown with lateral fringe of long yellow hairs; second, fifth and sixth

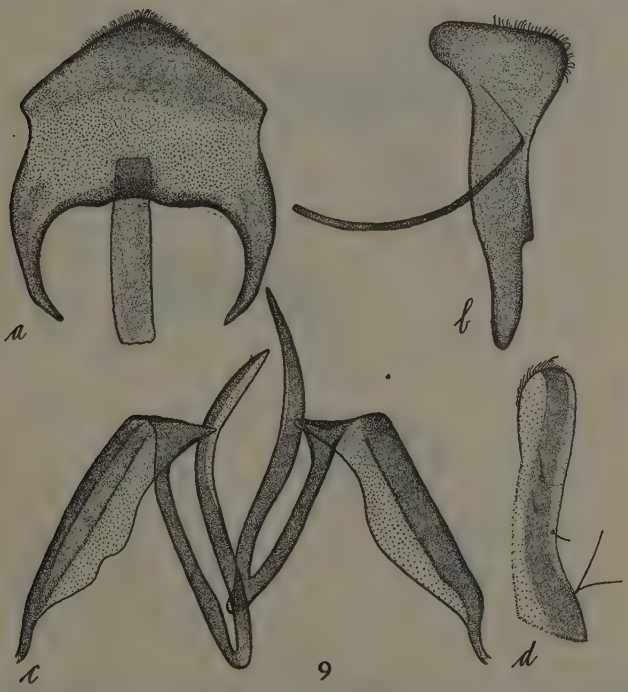

Fig. 9.—Male terminalia of *S. duodecimum :* anterior part, ventral view (*a*), lateral view (*b*); posterior part, dorsal view (*c*). Anal circus (*d*). (Magnification as in 3 *b*.)

segments as in *hirsutum*. *Terminalia. Coxite* (fig. 8 *d*) about half as long again as the clasper, narrowing gradually from the base to about half its basal width apically. *Clasper* slender and tapering very gradually with a terminal strongly chitinised tooth. *Phallosome : anterior part* (fig. 9 *a* and *b*) broad with inwardly curved basal processes in ventral view, in lateral aspect narrow and expanded anteriorly; *posterior part* (fig. 9 *c*) with long slender strongly chitinised parameres which are little more than twice the length of the apodeme. *Cercus* (fig. 9 *d*) long and narrow with a broad pigmented stripe. *Legs* as in female but generally darker. *Wing* as in female except for the presence of a basal cell and with few hairs only near the base of the subcosta.

Holotype ♂, R. Kigwe, 4,000 ft., Bukalasa, 30.vi.32.
Allotype ♀, same data.

Paratypes with types, 1 ♂, 2 ♀♀.
Reared from pupae.

Larva. Length, 5·5 mm. General colour dark grey. *Head. Front* with short spines but no distinct pigmented areas. *Antenna* as in *hirsutum. Mandible* (fig. 10 *a*) with a long median and two shorter strongly chitinised teeth and with one large and four smaller unchitinised teeth protruding from its lower surface. *Mentum* as in *hirsutum* but with terminal teeth as depicted in fig. 10 *b*. *Feeding-brushes* with about 45 long bristles. *Thorax.*

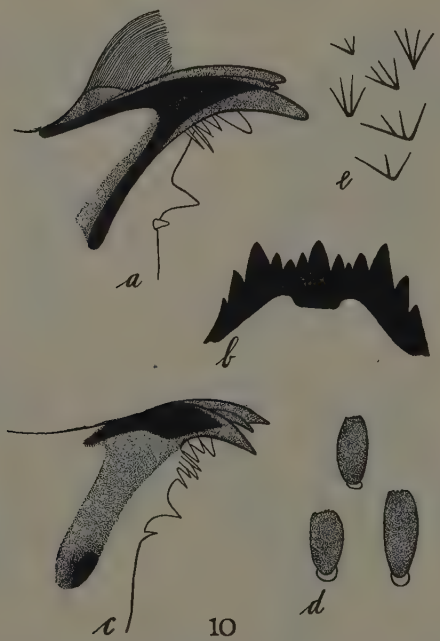

Fig. 10.—Larva, *S. duodecimum*, mandible (*a*), mentum (*b*); *S. tentaculum*, mandible (*c*), branched setae (*e*); *S. cervicornutum*, spatulate scales (*d*). (Magnification of *a*, *c*, *d*, and *e* as in fig. 3 *b*; *b* as in fig. 2.)

Thoracic pseudopod short and cylindrical reaching just above the head suture. *Abdomen. Anal gills* retracted and not visible in any of the specimens collected. *Anal sucker* as in *hirsutum.*

Pupa. Head and *thorax* with disc-like tubercles; trichomes as in *hirsutum. Respiratory organ* (fig. 5 *c*) pale and semi-translucent with an outer wall as in *hirsutum.* The twelve slender filaments are very uniform and arise from six short stems. *Abdomen.* Eighth and ninth segments with a basal row of short stout spines, the latter also with a terminal pair of downward projecting hooks. *Dorso-lateral surface:* second and third segments with four equally spaced hooks, sixth with four downward projecting spines. *Ventro-lateral surface:* third and sixth segments with a single slender spine, fifth with a pair of stout hooks, seventh segment with a pair of bifid spines.

Cocoon as in *S. hirsutum* but constructed of an open network of coarse threads.

Breeding-places.

S. duodecimum was found breeding in the River Kigwe near Bukalasa. The larvae and pupae were abundant on dirty stones lying on the river bed in muddy water eighteen inches deep and also on the dirty stems and blades of grass dipping in the water.

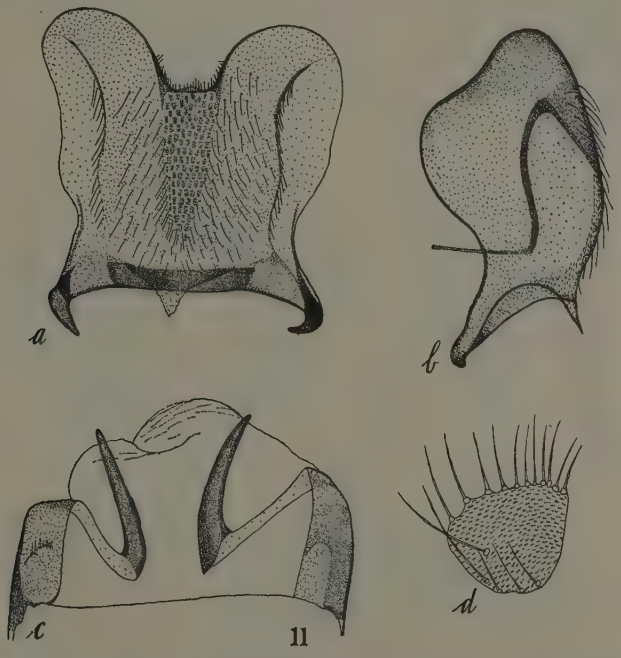

Fig. 11.—Male terminalia of *S. adersi*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*); posterior part, dorsal view (*c*). Anal circus (*d*). (Magnification as in fig. 2.)

Simulium adersi Pom.

This species was dealt with in a previous paper (1934), but as the respiratory organ and the ♂ terminalia (the parts of which previously were not dissected out and drawn separately) show similar characters to those described herein, they are given for purposes of comparison and to make the study more complete.

Male terminalia. Coxite (fig. 8 *c*) about twice as long as the clasper with an apical projection; *clasper* broad, of similar width apically as basally with a finger-like inner process bearing a chitinised tooth. *Phallosome: anterior part* (fig. 11 *a* and *b*) slightly wider apically than proximally with a median grove and short inwardly curved basal processes; *posterior part* (fig. 11 *c*) partly membranous with short apodemes bearing horn-shaped strongly chitinised parameres connected by a rod of semi-transparent chitin. *Cercus* as in fig. 11 *d*.

Simulium tentaculum sp. n.

♀. Length, 2·3 mm.; wing, 2·2 mm. *Head. Vertex, front* and *clypeus* slate-blue covered with golden scales. *Antenna* as in *hirsutum*. *Thorax. Mesonotum* dark grey thickly covered with brassy scales. *Scutellum* with long dark marginal hairs. *Pleura* dull brown. *Halteres* pale yellow with brown stem. *Abdomen* dark matt-brown, sparsely covered with dull golden scales; first tergite light brown with lateral fringe of long yellow hairs. *Terminalia* (fig. 1 *a*). *Eighth sternite* and *anterior gonopophyses* as in *S. hirsutum* with the exception of the former which lacks the lightly chitinised area. *Paraprocts* large and triangular. *Cerci* narrow and strongly chitinised. *Legs* dark brown; coxae and femora with the exception of the apex of the hind and middle legs yellow; hind tibiae with a broad yellow median band; fore and mid tibiae and first hind tarsal segment with basal two-thirds yellow. *Wing* as in *duodecimum* but with a basal cell.

♂. Length, 2·5 mm.; wing, 2·2 mm. *Head. Clypeus* and *antenna* dark brown. *Thorax. Mesonotum* velvet-black, covered with long narrow brassy scales except in the

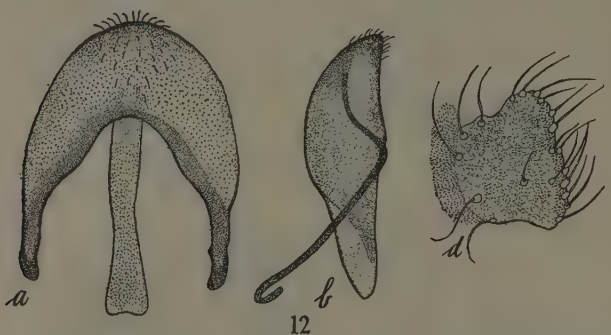

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Fig. 12.—Male terminalia of *S. tentaculum*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*). Anal circus (*d*). (Magnification as in fig. 2.)

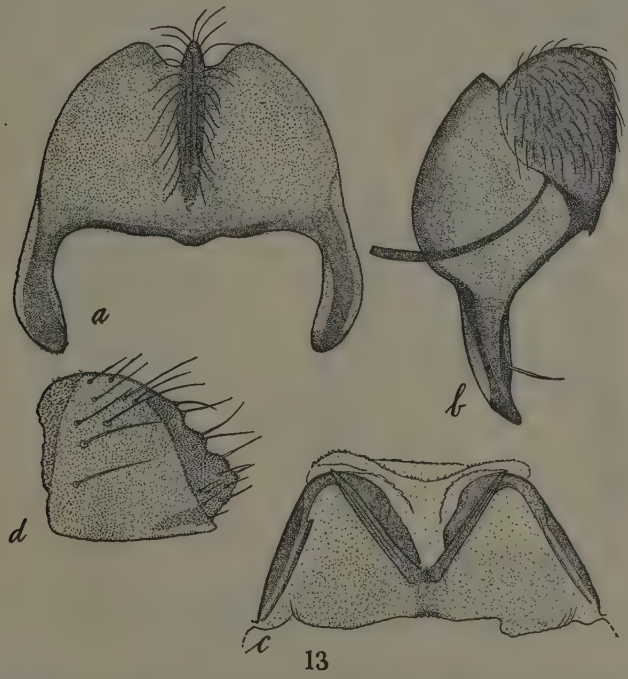
median area. *Scutellum* velvet-black with a few brassy scales and long black marginal hairs. *Pleura* slate-blue. *Halteres* dark brown. *Abdomen* velvet-black, sparsely sprinkled with short brassy scales; first tergite with lateral fringe of very long dark hairs; second, fifth and sixth segments with a light grey iridescent lateral patch. *Terminalia. Coxite,* clasper and the *posterior part of the phallosome* as in *ruficorne. Phallosome: anterior part* (fig. 12 *a* and *b*) semi-circular, and rounded distally with long downward projecting processes. *Cercus* as in fig. 12 *d*. *Legs* brown; femora and tibiae, sprinkled with golden scales; first hind tarsal segment with a decided sub-median bulge and narrow apically as in fig. 15 *a*. *Wing* as in female.

Holotype ♂, Lule, 6,000 ft., Mt. Nkokonjeru, 1.iv.32.
Allotype ♀, same data.
Paratypes, 11 ♂♂, 8 ♀♀ with types.
Reared from pupae.

Larva. Length, 6 mm. General colour dark grey. *Head. Front* lacking pigmented spots. *Antenna* as in *hirsutum*. *Mandible* (fig. 10 *c*) with three main strongly chitinised teeth, almost equal in length and with seven secondary lateral teeth with the usual pair situated below. *Mentum* as in *unicornutum*. *Feeding-brushes* with 40 long bristles. *Thorax. Thoracic pseudopod* long, inwardly curved and about half as long again as the

distance below the head suture. *Abdomen.* Terminal segments with small 3–4 branched setae as in fig. 10 *e*; last segment with a pair of ventral tubercles. *Anal gills* trilobed, median simple and lateral with a large main and two smaller secondary processes. *Anal sucker* as in *unicornutum*.

Pupa. Head and *thorax* with disc-like tubercles and simple trichomes. *Respiratory organ* (fig. 5 *b*) small, composed of twenty uniform, long, slender, semi-transparent filaments which arise from a common base and have no main stem; the outer wall is depicted in fig. 6 *a*. *Abdomen.* Terminal segments with a pair of inwardly curved hooks. *Dorso-*



13

Fig. 13.—Male terminalia of *S. brachium*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*); posterior part, dorsal view (*c*). Anal circus (*d*). (Magnification as in fig. 2.)

lateral surface: third and fourth segments with four equally spaced hooks; seventh, eighth and ninth with a basal row of downward projecting spines. *Ventro-lateral surface:* fourth segment with a single bifid spine; fifth, sixth and seventh with a pair of bifid spines; those on the last two segments widely spaced.

The cocoon is a dark brown, finely woven structure three millimetres in length as depicted in fig. 7 *e*.

Breeding-places.

Small black stones peppered with round holes provided the unique breeding-place of *S. tentaculum*. These stones were present in the River Nabigwo at 6,000 ft. in swiftly flowing water a few inches below the surface. The larva

chooses one of the small stones, pupates and makes a cocoon to cover it completely.

Simulium brachium sp. n.

♀. Length, 3 mm.; wing, 3·5 mm. *Head. Vertex, front* and *clypeus* slate-grey, densely covered with golden scales. *Antenna* dark brown with the exception of the scape and first flagellar segment which are light brown. *Palp* with a long sensory spot as in fig. 17 *c*. *Thorax. Mesonotum* dull black, very sparsely covered with short golden scales medially and with longer scales, which are more numerous, round the edges. *Scutellum* dull black, densely covered with long golden scales and with a marginal tuft of long golden hairs on either side. *Pleura* and *halteres* as in *hirsutum*. *Abdomen* dark brown, densely and uniformly covered with narrow golden scales; first tergite of similar colour with lateral fringe of pale yellow hairs. *Terminalia* (fig. 1 *c*). *Eighth sternite* with a median triangular chitinised area. *Anterior gonopophyse* as in fig. 2 *c*, similar in shape to those of

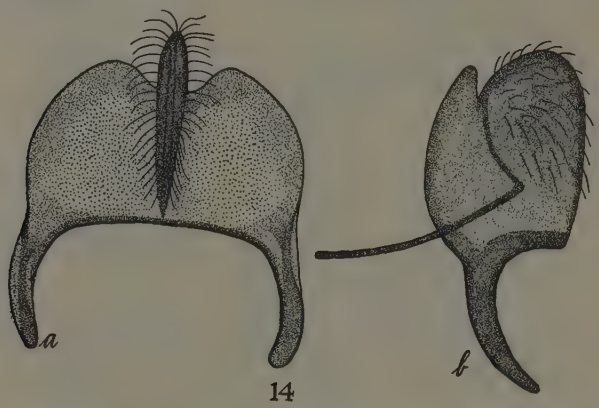


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Fig. 14.—Male terminalia of *S. simplex*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*). (Magnification as in fig. 2.)

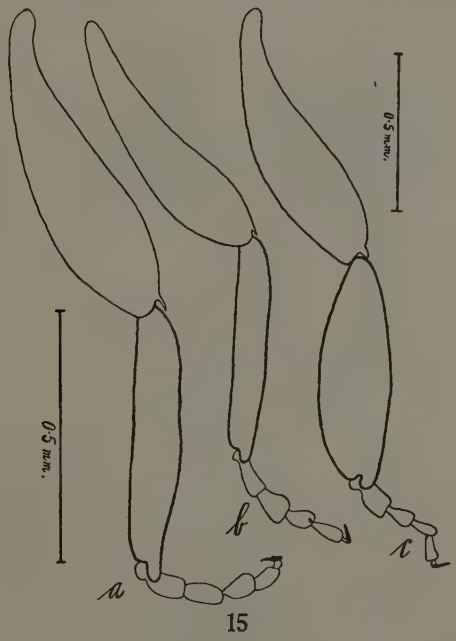
hirsutum but densely spiculate. *Paraprocts* and *cerci* as illustrated. *Legs* bright yellow with the exception of the tarsi and outer apical half of tibiae and femora which are dark brown. *Wings* as in *duodecimum*.

♂. Length, 3 mm.; wing, 3 mm. *Head. Clypeus* slate-grey with long dark hairs. *Antenna* dark brown. *Thorax. Mesonotum* velvet-black, uniformly and densely covered with closely applied dull brassy scales; those in the median area shorter than the rest. *Scutellum* dark brown, with brassy scales and with a marginal tuft of long black hairs on either side. *Pleura* brown. *Halteres* as in ♀. *Abdomen* dark velvet-brown; first tergite with lateral fringe of very long yellow hairs; second, third, fifth and sixth segments covered with brassy scales. *Terminalia. Coxite* (fig. 8 *a*) almost cylindrical in lateral view and about one and a half times the length of the clasper. *Clasper* rounded anteriorly with a strongly chitinised tooth situated on the lower apical edge. *Phallosome: anterior part* (fig. 13 *a* and *b*) broad basally with a median process bearing setae; downward projecting processes large and comparatively wide with a strong sub-basal anterior spine; *posterior part* (fig. 13 *c*) partly membraneous with long inward and downwardly curved apodemes forming a semi-circle and with long slender lanceolate parameres, anterior membrane with

a spiculate distal edge. *Cercus* as in fig. 13 *c*. *Legs* uniformly dark brown; first hind tarsal segment (fig. 15 *c*) large and expanded with a small apical incision between the broad anterior end and the calcipala. *Wing* as in *duodecimum* but without a basal cell.

Holotype ♂, Bumboi, 6,000 ft., Mt. Nkokonjeru, 28.iii.32.
Allotype ♀, same data.
Paratypes, 20 ♀♀, 37 ♂♂ with types.

Larva. Length, 6 mm. General colour dark grey. *Head. Front* without markings. *Antenna* slightly longer than the base of the feeding-brushes. *Mandible* and *mentum* as in *hirsutum*. *Feeding-brushes* with about 30 long bristles. *Thorax. Thoracic pseudopod*



15

Fig. 15.—Male hind leg. *S. tentaculum* (*a*), *S. hirsutum* (*b*), *S. brachium* (*c*).

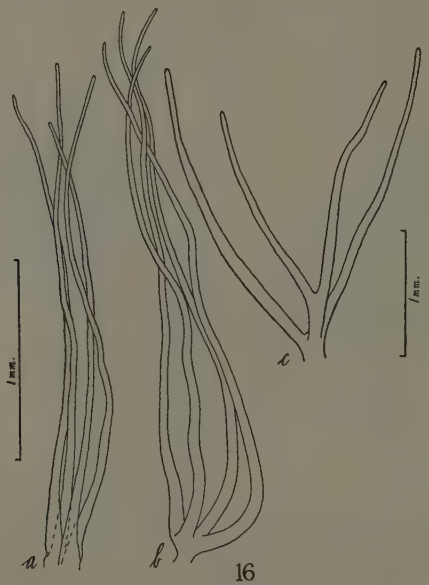
as in *hirsutum*. *Abdomen.* Terminal segments with a pair of ventral tubercles. *Anal gills* trilobed, each lobe with a large and 3–5 small finger-like processes. *Anal sucker* as in *hirsutum*.

Pupa. Head and *thorax* with disc-like tubercles; trichomes simple. *Respiratory organ* (fig. 16 *b*) composed of four slender semi-transparent filaments which are almost as long as the pupa and arise from a single stumpy stem. Under high magnification the outer wall (fig. 6 *d*) is seen to be covered with minute pigmented nodules. *Abdomen.* Terminal segment with two inwardly curved hooks. *Dorso-lateral surface :* third and fourth segments with four equally spaced hooks, sixth, seventh and eighth with four downward projecting hooks. *Ventro-lateral surface :* fourth segment with a simple slender spine and a bifid spine which are closely approximated; fifth and seventh segments with two bifid spines, those on the latter segment widely spaced; sixth with a single bifid and one simple stout spine, widely spaced.

The cocoon is a dark brown open network of coarse threads about five millimetres in length resembling in shape the cocoon of *S. hirsutum.*

Breeding-places.

In the River Naboinga at an altitude of about 6,000 ft. on Mount Nkokonjeru larvae and pupae of *S. brachium* were found attached to the stems and blades of grass and fern leaves dipping in swiftly flowing water. Pupae were most abundant in the groove on either side of the centre vein of the grass blades. On roots hanging in very effervescent water below falls the early stages were associated with those of *S. simplex.*



16

Fig. 16.—Pupa. Respiratory organ. *S. simplex* (*a*), *S. brachium* (*b*), *S. ruficorne* (*c*).

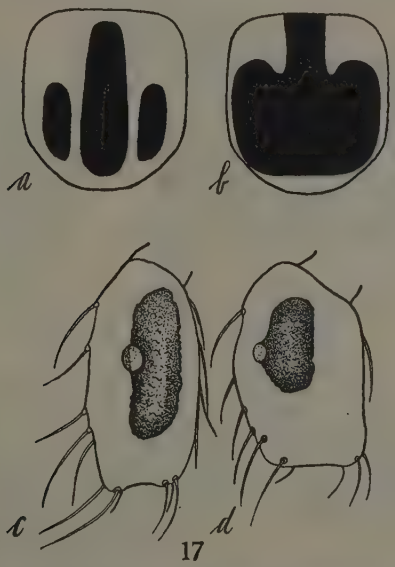
Simulium simplex sp. n.

♀. Length, 3 mm.; wing, 3 mm. *Head. Vertex, front* and *clypeus* slate-grey, densely covered with bright golden scales. *Antenna* as in *brachium. Palp* with small sensory spot as in fig. 17 *d. Thorax. Mesonotum* dull black, uniformly and densely covered with closely applied golden scales. *Scutellum* covered with golden scales and with long outstanding golden marginal hairs. *Pleura* and *halteres* as in *brachium. Abdomen* dark brown covered with brassy scales; first tergite and terminalia as in *brachium. Legs* as in *brachium* but generally darker. *Wing* as in *brachium.*

♂. Length and wing as in female. *Head. Clypeus* and *antenna* as in *brachium. Thorax* velvet-black, densely covered with pale yellow scales which are rather sparse in the median area. *Scutellum* dark brown with lateral marginal tufts of long pale yellow hairs. *Pleura* and *halteres* as in female. *Abdomen* dark brown, densely covered with golden scales on the first to sixth segments inclusive; those on the first three long and narrow; first tergite

with a dense lateral fringe of very long pale yellow hairs extending to the base of the fifth segment. *Terminalia. Coxite* and *clasper* as in *brachium. Phallosome: anterior* part (fig. 14 *a* and *b*) differing from *S. brachium* in the median process which is relatively longer and extends from the base to above the anterior edge and in the downward projecting processes which are distinctly more slender; *posterior part* and cercus as in *brachium. Legs* dark brown with the exception of the basal third of the hind tibiae. Fore coxae, femora and tibiae speckled with yellow scales. *Wings* as in *brachium.*

Holotype ♂, Bumboi, Mt. Nkokonjeru, 6,000 ft., 13.iv.32.
Allotype ♀, same data.
Paratypes, 6 ♂♂, 5 ♀♀ with types; 4 ♂♂, 4 ♀♀, R. Kaptokoi, 5,000 ft.



17

Fig. 17.—Adult. Pattern on thorax of *S. ruficorne* (diagrammatic) female (*a*), male (*b*). Third segment of female palp showing sensory spot *S. brachium* (*c*), *S. simplex* (*d*). (Magnification of *c* and *d* as in fig. 1 *a*.)

Larva as in *brachium*, but longer (eight millimetres) and with the mentum which has a row of seven in place of four stout spines.

Pupa. Head and *thorax* as in *brachium* but differing in the respiratory organ (fig. 16 *a*). The four long slender filaments arise from the base and lie vertically; there is no main stem and the filaments are compact, whereas in *brachium* they spread out from the base. In general colour the organ is distinctly darker and the outer wall shows the fine striated appearance depicted in fig. 6 *e*.

Cocoon as in *hirsutum* but four mm. in length and differing markedly from *brachium* in texture.

Breeding-places.

These have already been dealt with under the previous species.

Simulium ruficorne Macquart.*

♀. Length, 3 mm.; wing, 2·5 mm. *Head. Vertex, front* and *clypeus* slate-grey, densely covered with narrow silver scales. Antenna light brown with the exception of the scale, first and base of second segments which are yellow. *Thorax. Mesonotum* slate-blue, densely covered with silver scales with three broad black stripes (fig. 17 *a*) which are covered with short deep brown scales; the median stripe is about twice the length of the lateral stripes and extends almost from the scutellum to the anterior edge. *Scutellum* slate-blue covered with silver scales and with long pale marginal hairs. *Pleura* light grey. *Halteres* entirely pale yellow. *Abdomen* brown, densely covered with long narrow silver scales; first tergite brown dorsally covered with silver scales and pale yellow laterally with a fringe of silver hairs. *Terminalia* as in *S. brachium* but without the median chitinised patch of

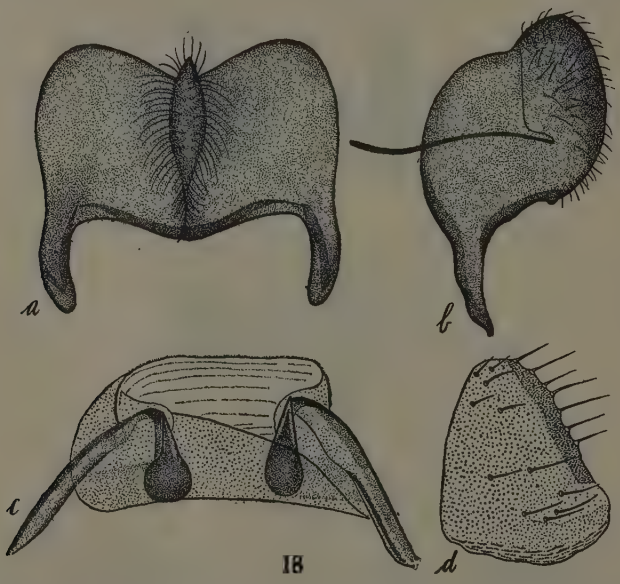


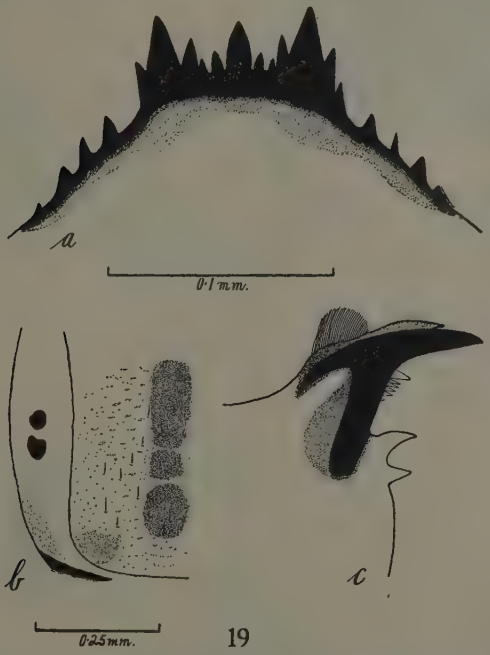
Fig. 18.—Male terminalia of *S. ruficorne*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*); posterior part, dorsal view (*c*). Anal circus (*d*). (Magnification as in fig. 2.)

the eighth sternite. *Legs* bright yellow with the exception of the apex of the femora and tibiae of the hind and middle legs and of the fore tibiae and the tarsi (excepting the basal two-thirds of the first hind tarsal segment) which are brown. *Wing* as in *duodecimum*.

♂. Length, 3 mm.; wing, 2·5 mm. *Head. Front* and *clypeus* light grey with sparse black hairs. *Antenna* yellowish-brown with the exception of the second segment which is brown and longer than the rest. *Thorax. Mesonotum* slate-blue, densely covered with silver scales with a large black median area (fig. 17 *b*) having short deep brown scales. *Scutellum* with long black marginal hairs. *Pleura* slate-blue. *Halteres* pale yellow.

* In an addendum to a paper on the Simuliidae of Java and Sumatra (1934, *Arch. Hydrobiol.* (Supp.) **13** : 136–137) Edwards suggested that the African *S. diversipes* Edw., *S. beckeri* Roub., and *S. divergens* Pom., are synonyms of *S. ruficorne* Macquart.

Abdomen velvet-brown sparsely covered with dark brown scales with the exception of the fifth and sixth segments which are covered with narrow golden scales; first tergite velvet-brown with lateral fringe of very long light brown hairs. *Terminalia. Coxite* (fig. 8 *b*) about half as long again as the clasper, in ventral view of almost similar width basally as apically. *Clasper* broadening gradually to twice its basal width anteriorly with a straight apical edge and a small chitinised tooth in its lower corner. *Phallosome : anterior part* (fig. 18 *a* and *b*) somewhat similar to *brachium* and *simplex* but as wide apically as basally in ventral view; downward projecting processes in lateral view terminating in a sharp tip; *posterior part* (fig. 18 *c*) partly membranous, apodeme with conical paramere. *Cercus* as in fig. 18 *d*. *Legs* yellow with the exception of the femora, the apical half of the tibiae



19

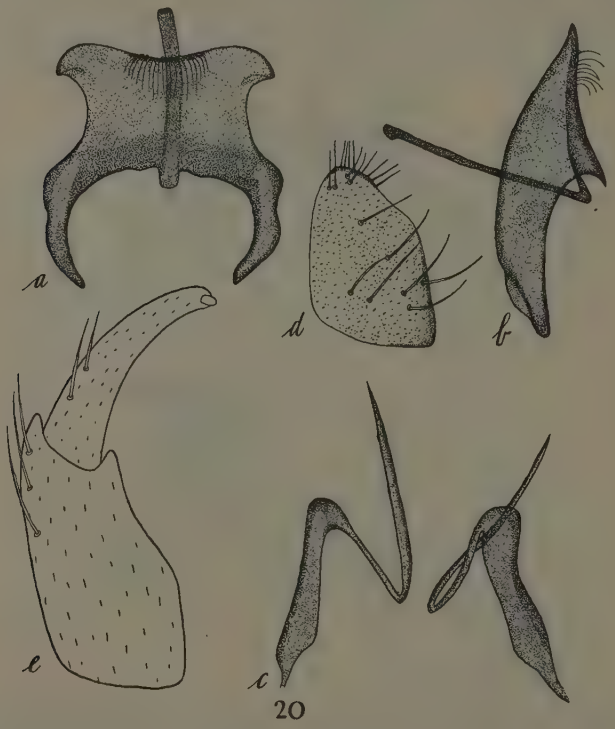
Fig. 19.—Larva, *S. ruficorne*, anterior part of mentum (*a*), part of head showing front with pigmented areas (*b*), mandible (*c*). (*a* and *c* to same magnification.)

and the tarsi; pale basal area of the tibiae with a narrow brown band which is not so marked on the front legs.

Larva. Length, 7 mm. General colour light brown covered with short spines. *Head. Front* with three median pigmented areas and short strong spines as depicted in fig. 19 *a*. *Antenna* as in *hirsutum. Mandible* (fig. 19 *c*) with a main strongly chitinised tooth and another tooth which is less strongly chitinised and shorter situated above, and five secondary teeth protruding from its concave surface; the usual paired lateral teeth are very prominent and greatly enlarged in this species. *Mentum* with a terminal row of nine strongly chitinised teeth and 5–6 slightly chitinised lateral teeth, all of which are sharply pointed (fig. 19 *b*), the outer tooth is of similar length to the median and bears on either side at its base two smaller teeth of almost equal length, between the inner small tooth and the median lie two smaller teeth of which the outer is slightly the longer; on either side extending from

the base is an oblique row of six stout spines. *Feeding-brushes* as in *hirsutum*. *Thorax*. *Thoracic pseudopod* short and broad, terminating below the head suture. *Abdomen*. Terminal segment with a pair of ventral tubercles. *Anal gills* as in *hirsutum*. *Anal sucker* with about 60 rows of 10–15 hooks.

Pupa. *Head* and *thorax* with disc-like tubercles, trichomes short and simple. *Respiratory organ* (fig. 16 *c*) pale and semi-translucent and exceedingly fragile. The four long comparatively thick filaments spread out from a short stem and have a finely reticulated



20

Fig. 20.—Male terminalia of *S. unicornutum*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*); posterior part, dorsal view (*c*). Anal circus (*d*). Coxite and clasper, ventral view (*e*). (Magnification as in fig. 2.)

outer wall (fig. 6 *b*); they are arranged in pairs, a long median pair and a slightly shorter pair which arise from a short stem. *Abdomen*. Terminal segment with a pair of inwardly curved hooks. *Dorso-lateral surface:* third and fourth segments with four equally spaced hooks, eighth segment with four closely approximated downward projecting spines. *Ventro-lateral surface:* fifth, sixth and seventh segments with a pair of short spines, those on the two latter segments widely spaced.

The cocoon is a light brown coarsely woven gelatinous structure five millimetres in length with an irregular rim and long median and lateral projections as illustrated in fig. 7 *f* and *g*.

Breeding-places.

The larvae and pupae of *S. ruficorne* were numerous on dead and living grass blades and on stalks exposed to bright sunlight lying in a few inches of muddy water in the River Tabogonye at an altitude of 4,000 ft.

Simulium unicornutum Pom.

♀. Length, 2·5 mm.; wing, 2·2 mm. *Head. Vertex, front* and *clypeus* slate-grey with sparse yellow scales. *Antenna* dark brown, scape, first and base of second segment yellow. *Thorax. Mesonotum* and *scutellum* dull black, covered with golden scales; the latter with long marginal hairs. *Pleura* dark brown. *Halteres* brown. *Abdomen.* First and second segments dark brown with golden scales; remaining segments shiny brown with sparse golden scales; first tergite dark brown, with a lateral fringe of short yellow hairs. *Terminalia* as in *brachium. Legs* dark brown. Front femora and tibiae with golden scales; basal third of tibiae of hind and mid legs golden, the former with a brown spot, basal two-thirds of first hind tarsal segment yellow. *Wings* as in *duodecimum* but with a basal cell.

♂. Length, 1·5 mm.; wing, 2·2 mm. *Head. Clypeus* dark grey with black hairs. *Antenna* dark brown. *Thorax. Mesonotum* velvet-black covered with deep golden scales with the exception of the median area. *Scutellum* velvet-black with golden scales and long marginal hairs. *Pleura* slate-blue. *Halteres* velvet-brown. *Abdomen* velvet-black sparsely covered with dark brown hairs, with an iridescent slate-blue lateral patch on the second, fifth and sixth segments; first tergite velvet-black with long dark brown hairs. *Terminalia* (fig. 20). *Coxite* relatively short and of equal length to the clasper, distal end, which is rather narrow at the base, is produced into an inner and an outer projection. *Clasper* long and slender, tapering gradually to a rounded end about half its basal width, with a strong tooth at the tip. *Phallosome : anterior part* (fig. 20 *a* and *b*) broad and narrow medially; downward projecting processes long and inwardly curved; lateral view shows the convex dorsal side and the pointed distal end; *posterior part* (fig. 20 *c*) lacking membrane, apodeme terminating in a very long spine-like paramere, *cercus* as in fig. 20 *d*. *Legs* as in ♀ but with the basal two-thirds of the first hind tarsal segment brown. *Wing* as in ♀.

Larva. Length, 4 mm. General colour grey. *Head. Front* with a chitinised area covered with short spines as depicted in fig. 21 *b*. *Antenna* as in *hirsutum. Mandible* (fig. 21 *c*) with a strong main chitinised tooth bearing two short secondary teeth, similarly chitinised which are situated near its base, and with two more large teeth situated above; the usual lightly chitinised lateral teeth which protrude from the concave surface are seven in number. *Mentum* (fig. 21 *d*) rather similar to *hirsutum* but with the terminal teeth longer and more pointed. *Feeding-brushes* with 18–20 long bristles. *Thorax. Thoracic pseudopod* short, twice as long as the distance below the head suture. *Abdomen.* Terminal segments with strongly chitinised narrow spatulate scales as in fig. 21 *e*; last segment with a pair of ventral tubercles. *Anal gills* (fig. 21 *a*) trilobed, the median lobe with six and the lateral with nine finger-like processes. *Anal sucker* with about 100 rows each with 10–12 strong hooks.

Pupa. Head and *thorax* lacking disc-like tubercles, trichomes simple. The respiratory organ (fig. 22 *d*) is a conspicuous, characteristically shaped, semi-transparent tube with a finely reticulated outer wall (fig. 22 *e*). It lies in a dorso-ventral position and is attached to the thorax in its anterior quarter. *Abdomen.* Terminal segment with a pair of downward projecting hooks. *Dorso-lateral surface :* third and fourth segments with four equally spaced hooks, seventh with four and eighth with many downward projecting spines. *Ventro-lateral surface :* fourth segment with one bifid spine, fifth with two closely

approximated bifid spines, sixth and seventh with a bifid inner and a simple outer spine which are widely spaced.

The cocoon (fig. 7 *c* and *d*) is a dark brown, finely woven, shield-like structure, 3 millimetres in length.

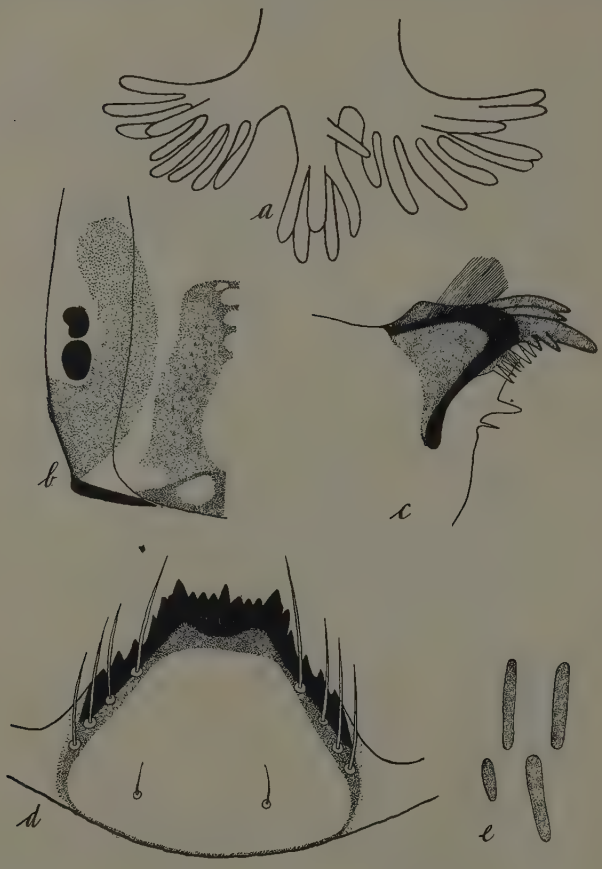


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Fig. 21.—Larva of *S. unicornutum*. Anal gills (*a*), part of head showing pigmented areas of front (*b*), mandible (*c*), mentum (*d*), spatulate scales of terminal segments (*e*). (Magnification of *a* as in fig. 1 *c*; *b* as in fig. 15 *a*; *c* and *e* as in fig. 3 *b*; *d* as in fig. 2.)

Breeding-places.

In the slowly moving river of the Sezibwa (4,000 ft.), where no visible aeration was perceptible, larvae and pupae of *S. unicornutum* were abundant on the leaves of a species of *Potamogeton* growing in shallow water, three to six inches deep. Some were found on grass blades dipping in the stream and

others on upright stems of papyrus. They were more numerous near bends in the course of the river where the water had gained momentum.

Simulium cervicornutum Pom.

♀. Length, 2·2 mm.; wing, 1·7 mm. *Head. Vertex, front* and *clypeus* grey covered with golden scales. *Antenna* brown, with the exception of the scape, first and basal half of second segment which are yellow. *Thorax. Mesonotum* and *scutellum* dull black, densely and uniformly covered with bright golden scales, the latter with long bright golden marginal hairs. *Pleura* slate-blue. *Halteres* pale yellow. *Abdomen* dull black

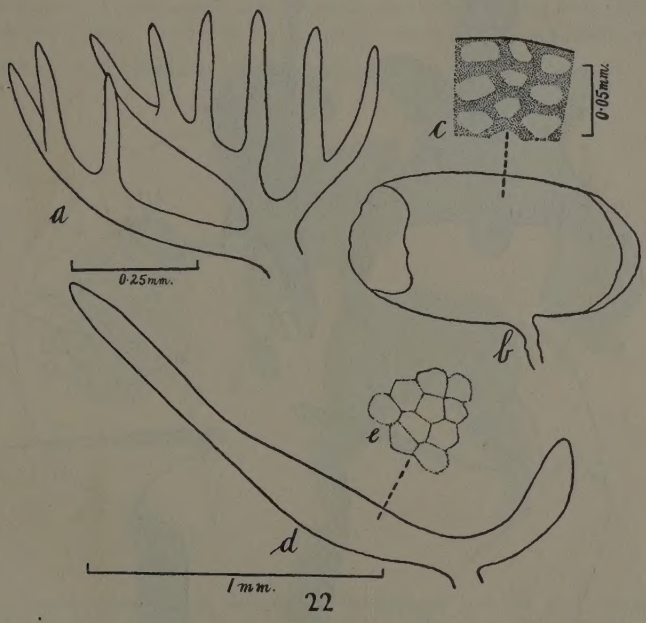

Fig. 22.—Pupa. Respiratory organ. *S. cervicornutum* (*a*); *S. rotundum* (*b*), outer wall of same (*c*); *S. unicornutum* (*d*), outer wall of same (*e*). (Magnification of *b* and *d* and *c* and *e* similar.)

(seventh and eighth segments shiny black), densely covered with bright golden scales except the terminal segments where the scales are sparse; first tergite of similar colour with a dense fringe of short golden hairs. *Terminalia* as in *brachium. Legs.* Femora and tibiae of fore and mid legs pale with dense golden pubescence; hind legs, femora and basal half of tibiae and first tarsal segment with golden scales; tarsi of all legs dark brown. *Wing* as in *duodecimum.*

♂. Length, 2 mm.; wing, 1·7 mm. *Head. Clypeus* dark grey with pale yellow hairs. *Antenna* dark brown with the exception of the base of the third segment which is yellow. *Thorax. Mesonotum* and *scutellum* dull black, densely and uniformly covered with bright golden scales, the latter with long marginal golden hairs. *Pleura* as in female. *Halteres* pale yellow with light brown stem. *Abdomen* velvet-black with sparse pale hairs; first tergite with a dorsal fringe of golden scales and a lateral fringe of long dark hairs; fifth

and sixth segments with a light grey iridescent lateral patch. Uganda specimens lack the lateral patch on the seventh segment as noted by Pomeroy (1920). *Terminalia* (fig. 23). *Coxite* slightly longer than the clasper tapering to about half its basal width apically. *Clasper* narrow at the base and widening gradually into a rounded anterior end with a short apical process which carries a small tooth. *Phallosome: anterior part* (fig. 23 *a* and *b*) rather similar to *S. unicornutum* in ventral aspect but wider basally than apically and with a broad median process; in lateral view it is entirely dissimilar and wide distally with a short posterior process directed backwards; *posterior part* (fig. 23 *c*) lacking membrane

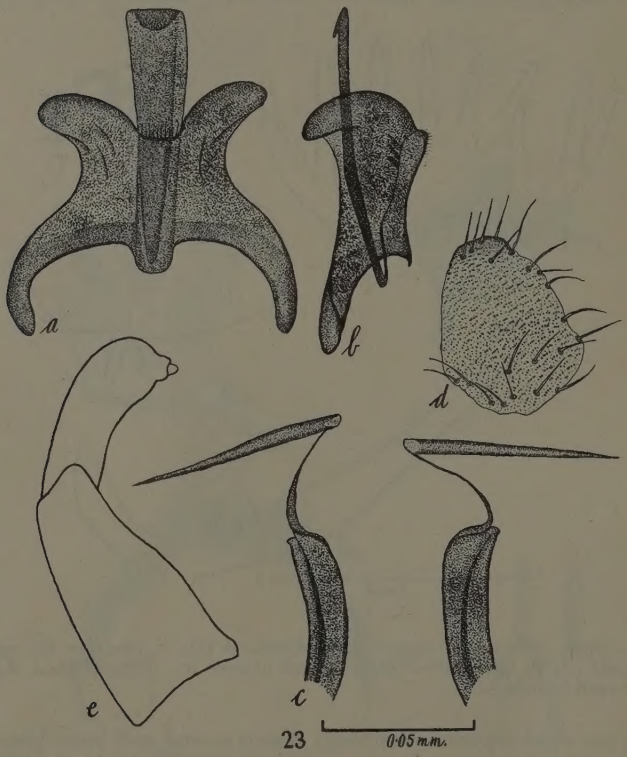

Fig. 23.—Male terminalia of *S. cervicornutum*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*); posterior part, dorsal view (*c*). Anal circus (*d*). Coxite and clasper, ventral view (*e*). (Magnification of *a*, *b*, *c*, and *d* the same; *e* as in fig. 2.)

with long slender conical parameres. *Cercus* as in fig. 23 *d*. *Legs* as in ♀ but generally darker. *Wing* as in *duodecimum* but with no basal cell.

Larva. Length, 5 mm. General colour light brown. *Head. Front* as in *hirsutum* but with stout spines. *Antenna, mandible, mentum* and *feeding-brushes* as in *hirsutum*. *Thorax. Thoracic pseudopod* long and slender, about one and a half times the distance below the head suture. *Abdomen.* Terminal segments with strongly chitinised broad

spatulate scales as in fig. 10 *d*; last segment with a pair of ventral tubercles. *Anal gills* and *sucker* as in *S. unicornutum*.

Pupa. Head and *thorax* with disc-like tubercles and bifid trichomes. *Respiratory organ* (fig. 22 *a*) pale and semi-translucent with an outer wall of similar structure to *brachium* (fig. 6 *d*). Aptly described by Pomeroy as resembling the antlers of an elk, the organ is composed of tubular filaments which arise from three main stems; the median with four branches and the lateral, one of which has a longer stem than the other, with two and three branches respectively. *Abdomen.* Terminal segment with two inwardly curved hooks. *Dorso-lateral surface:* third and fourth segments with four strong equally spaced hooks, seventh with five equally spaced spicules, eighth and ninth segments with downward projecting spines. *Ventro-lateral surface:* fourth and fifth segments with one and two bifid spines respectively; sixth and seventh segments with a bifid and a simple spine.

Cocoon as in *S. hirsutum*, but 2·5 millimetres in length.

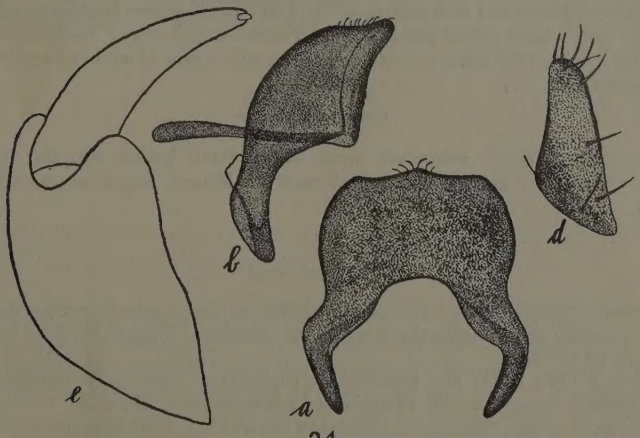

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FIG. 24.—Male terminalia of *S. rotundum*. Phallosome: anterior part, ventral view (*a*), lateral view (*b*). Anal circus (*d*). Coxite and clasper, ventral view (*e*). (Magnification as in fig. 2.)

Breeding-places.

Described under *S. hirsutum*.

Simulium rotundum sp. n.

♀. Length, 2 mm.; wing, 2·2 mm. *Head* and *thorax* as in *cervicornutum*. *Abdomen* lustrous black; first tergite with a dorsal fringe of golden scales and a lateral fringe of long yellow hairs; second segment densely covered with golden scales. Terminalia as in *S. hirsutum*. *Legs* brown, femora and fore tibiae sprinkled with yellow scales; mid and hind tibiae with yellow bases and a broad submedian yellow band; hind basal two-thirds of first tarsal segment yellow. *Wing* as in *duodecimum*, but with a basal cell.

♂. Length, 2·1 mm.; wing, 2·3 mm. *Head. Clypeus* black with sparse golden scales. *Antenna* black. *Thorax. Mesonotum* and *scutellum* velvet black, densely covered with golden scales, the latter with long yellow marginal hairs. *Pleura* slate-grey. *Halteres*

yellow, stem brown. *Abdomen* velvet-black, lightly sprinkled with golden scales; first tergite dark brown with a fringe of light brown hairs; fifth and sixth segments with a lateral slate-grey iridescent patch. *Terminalia* (fig. 24). *Coxite* large, about as long as the clasper with an inner and an outer apical process. Clasper tapering to the tip which bears a small tooth. *Phallosome : anterior part* (fig. 24 *a* and *b*) slightly narrower apically than proximally; basal processes directed outwards and then inwards; posterior part as in *unicornutum*. *Cercus* as in fig. 24 *d*. *Wing* as in *duodecimum*.

Holotype ♂, River Kyebonet, 6,000 ft., Mount Elgon, 4.v.32.
Allotype ♀, same data.
Paratypes, 1 ♀ with types.

Larva unknown.

Pupa. *Head* and *thorax* with disc-like tubercles and simple trichomes. Respiratory organ (fig. 22 *b*) of unique shape, large and oval, with open ends and with an outer wall as in figure. *Abdomen*. Terminal segment with a pair of inwardly curved hooks. *Dorso-lateral surface :* fourth and fifth segments with four equally spaced hooks; seventh, eighth and ninth with a basal row of short spines. *Ventro-lateral surface :* fourth and fifth segments with a single bifid spine, seventh and eighth with a pair of bifid and a pair of simple spines respectively.

Breeding-places.

Three pupae of *S. rotundum* were taken from leaves dipping in swiftly flowing water in a heavily shaded stream on Mount Elgon at an altitude of 6,000 ft.

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